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ABSTRACT

Whether physical activity and verbal communication would affect kindergarten students' scores on the Metropolitan Readiness Tests (MRT) was investigated. Twenty subjects were administered Level I of the MRT when they entered kindergarten. For 5 days per week for 4 weeks, the 10 subjects in the experimental group worked at constructive play tasks with various materials. During task activities, subjects worked in pairs which were separated by a barrier completely obstructing their views of each other's constructions. One dyad member gave only verbal information about the object he or she had made to the other whose task was to make an identical object. Discussion and questions were encouraged, but no visual communication between dyad members was allowed. Upon completion of the task, the barrier was removed and subjects were able to compare their constructions, make adjustments in the copy, and agree on the likeness of the two constructions. Control subjects remained in their classroom and were involved in small and whole group lessons. Level II of the MRT was administered as a post-test. Results indicate that, while experimental and control group pretest scores did not differ significantly and both groups posttest scores improved significantly, the experimental group's posttest scores were significantly greater than those of the control group. It is concluded that school readiness may be a more complex phenomenon than the maturity factor alone would indicate. (Author/RH)

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Constructive Play

Building Symbolic Competence Through Physical Activity and Social Interaction

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Author Notes

This article is based on a Master's Thesis submitted to the Department of Elementary Education, San Jose State University, August, 1984, by the author.

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Running head: SYMBOLIC COMPETENCE THROUGH CONSTRUCTIVE PLAY

Abstract

School readiness concerns educators of young children. Maturity is often thought to be the deciding factor in determining a child's potential. The Metropolitan Readiness Tests, MRT, is a measure based on maturity (Osborn, in Buros, 1968). Piaget (1964/1967) has theorized that knowledge is constructed through action on objects and social interaction. The progress of development is mediated by maturity and previous knowledge. Ten kindergarten students engaged in a constructive play activity in which verbal communication was encouraged. The children worked in pairs. Each child created a block construction then verbally communicated directions to a partner for reproducing it, sight unseen. Following four weeks of treatment, the children were given MRT, Level II. Their scores were compared to those of a control group. Results indicate that a relationship exists between success in physical problem solving tasks, when verbal communication is encouraged, and symbolic problem solving competence. School readiness may be a more complex phenomenon than the maturity factor alone would indicate.

Constructive Play

Building Symbolic Competence Through

Physical Activity and Social Interaction

Kindergarteners and first graders vary widely in their readiness for school. The riddles of reading, writing, and mathematics fall easily into place for some. More meet the challenges with varying degrees of difficulty. Some fail altogether. School readiness has long been thought to be dependent upon the time required for adequate maturing to take place (Ilg & Ames, 1964). The terms readiness and maturity are often used interchangeably. The Metropolitan Readiness Tests, or MRT (Hildreth, McGauvran & Griffiths, 1977), is an instrument used to test school readiness. According to Osborn (in Buros, 1968) it measures a number of basic skills which are of importance in beginning reading and mathematics. The authors of the MRT list certain characteristics of maturity including intelligence, health and physical condition, emotional factors, social adjustment, and general background of experience. Gallagher and Reid (1981) define maturity as a spontaneous process of development, linked to the child's total growth, including changes in the body, nervous system, and in intellectual functions.

Osborn states that trying to teach children who are not yet ready to learn is futile as well as dangerous. He observes that the MRT has been widely used to identify those children who are not mature enough to benefit from ordinary first grade instruction. Ilg and Ames note that as parents become better informed about school readiness, more are holding their children out of kindergarten and first grade, even when chronological age makes

them eligible.

The developmental theorist, Jean Piaget (1964/1967) devised a model for the construction of knowledge which includes maturity but does not capitalize on it. Maturation is but one factor in an ongoing process which also includes physical activity and social interaction. A fourth factor is equilibration, a plateau of understanding, which regulates the interaction of the other three (Elkind, in Piaget, 1964/1967). Knowledge is the result of these interactive processes of assimilating and accomodating new experience. Assimilation involves the fitting of new experience into previous knowledge. While, accomodation is the modification of previous knowledge through experience.

Piaget notes two basic intellectual operations arising from these processes: classification and seriation. He defines an operation as internalized action which is reversible and may coordinate with other operations. The individual continuously classifies and seriates the physical objects encountered in daily experience. This natural ordering of experience leads to the formation of concepts. Elkind (1969) defines the term concept as the mechanism by which experience is ordered. Abstract systems of knowledge such as language and mathematics are based upon relationships involving the mental operations of classification and seriation. Performance of these operations leads to an ability to perceive part-whole relationships among and within objects.

The young child interacts with the environment making discoveries about the actions performed as well as the objects of those actions. Constructive play is often the medium for these

discoveries. Reifel (1984) notes that when children play with blocks they are thinking, developing concepts. He sees that they may acquire some of their spatial understanding through constructive play. Piaget (1964/1967) has observed that as children engage in such activity, they gradually develop an awareness that objects have their own existence. He terms this awareness object permanence. Along with object permanence there develops a practical sense of space derived from the coordination of the child's movements in relation to objects. This knowledge of objects and spatial relations is established through many interactions with the environment. The child comes to know the object in all its various aspects. An object identity emerges which will eventually enable the child to maintain object recognition through apparent changes in the appearance of the object. Kamii (1973) states that such knowledge cannot be obtained through static perception alone.

The child interrelates many objects within the perceptual field as thought develops. The processes of classification and seriation lead to discoveries about the actions performed upon objects. Gradually actions are separated from their objects. Conservation is the ability to maintain object identity in the face of actions which alter the appearance of the object (Elkind, 1969). An awareness develops that actions can be reversed to return the object to its original state, maintaining object identity. Rolling a ball of clay into a sausage does not alter its substance. The action can be reversed to return the clay to its original state. Such transformations must be taken into account in order to comprehend the reversibility of actions.

This process is difficult for the young child.

Piaget (1964/1967) states that nonconservation is the result of the fact that young children reason only about states (static configurations) and neglect to account for transformations. Attention tends to be centered on certain aspects of the perceptual field to the exclusion of others. Perception will only gradually decenter through experience. The child will then be able to consider many variables at one time. Numerous interactions will be required to build such understandings.

It seems that the child utilizes these same processes in dealing with the symbolic puzzles encountered in the classroom. The MRT is a sampling of such tasks, an indicator of readiness for abstract problem solving. The child must solve a puzzle of form and sequence on the printed page in order to communicate understanding of the task at hand. A typical reading workbook at the first grade level might require a beginning or ending phonetic symbol be place either to the left or right of a picture to indicate the placement of a sound at the beginning or end of a word. A math workbook at the same level may require the child to count all the objects in one box while disregarding those in other boxes, progressing from left to right, top to bottom, along the printed page.

In order to succeed in first grade, the child must be able to classify and seriate the signs and symbols of the representative system. These processes must be carried out in an ordered manner from top to bottom, left to right often within the confines of lines and boxes. The child cannot function in relation to the academic task without doing so. A spatial reference system must

be developed in which objects are perceived in an ordered fashion. A personal space must be conceptualized in which the self is viewed as one objects among others (Piaget & Inhelder, 1967).

Furth and Wachs (1975) see the child orienting for action within a spatial framework. They contend that a knowledge of body axes and visual thinking are related. They state that the retina, like the body, may be divided into quadrants: upper and lower right, upper and lower left. There must be a matching of retinal and body quadrants in order for the individual to act on objects in space. While visual thinking locates the object, movement thinking enables the individual to act upon it. Visual thinking, laterality, and directionality are integrated to form a relative constancy of objects in space. This is the foundation for learning directionality in letters, words, and numerals. Thus, the child is able to deal with differences such as "b" versus "d", "saw" versus "was", and "13" versus "31".

As the child moves into reading, the focus of attention expands to include symbols as well as objects. Elkind (1966) found the processes of schematization and reorganization to be essential to successful reading. Schematization involves the coordinating of wholes and parts so that both retain their unique identity while maintaining their interdependence. Perceptual reorganization is mental action upon a configuration which results in a new organization without physically altering the configuration. This process is difficult for the young child who must recognize that the same element can give rise to different forms depending upon context. Elkind concludes that activity is important in the process of perceptual development. It is especially relevant in

the early stages of reading in which up-down and left-right scanning patterns are acquired. He believes that the advantage in the application of Piaget's theory to reading lies in the fact that it is based upon consideration of the complex and varied perceptual acts which the child must perform in learning to read.

The foundation laid by constructive play in early childhood may well lead to greater competence in dealing with symbols in reading, writing, and mathematics. Some sort of social interaction also seems to be necessary to bring such concepts to consciousness, to modify and clarify understanding of the cause-effect relationships involved (Piaget, 1971). Personal experience is decentered and objectified through language in interaction with other beings. Thought is the abstraction of action upon objects. Language is patterned by society. Verbal communication facilitates the expansion of thought, adding to its flexibility (Elkind, in Piaget, 1964/1967). This is accomplished as personal experience is accomodated to the experiences of others. Once language appears, it is in constant interaction with thought. Understanding is thus objectified and development furthered as physical action is reinvented in imagination to be expressed in words (Piaget, 1971).

Barsch (1967) found the size and richness of the symbol system to be dependent upon experience. If physical activity is limited, language will also be limited. In order to succeed in school the child must be able to classify and seriate signs and symbols, both visually and aurally. A spatial reference system must be developed in which objects are perceived in an ordered

fashion. A personal space must be conceptualized in which the self is viewed as one object among others (Piaget & Inhelder, 1967). Constructive play allows the child to deal with problems of proximity, separation, and enclosure of the elements of the whole. Reifel (1984) states that play experiences which include symbolic representation of spatial relations may contribute to the child's spatial awareness, leading to better spatial understanding later in life.

Piaget (1964/1967) and others have found that the young child must actively explore and manipulate the environment as development proceeds. Maria Montessori (1963) spoke in favor of an active environment for the young child. She states that, "Education is a natural process spontaneously carried out by the individual and is acquired not by listening to words but by experiences upon the environment" (p. 3). The child must also interact with other beings in order to extend knowledge gained through physical activity (Piaget, 1971). Inherent in logical systems such as language and mathematics, are spatial relations which allow the individual to discern differences and similarities among and within objects. Left, right, center, top, bottom, before, and behind must be related in order to form an understanding of the part-whole relationships necessary to the performance of intellectual operations (Corballis & Beale, 1976). The subject's activity within the environment is central to the development of intelligence (Piaget, in Gallagher & Reid, 1981).

The purpose of this study was to determine whether physical activity, involving action on objects, and social interaction, involving verbal communication among children, would have an

effect on kindergarten student's scores on the Metropolitan Readiness Tests. If knowledge is constructed out of the individual's physical and social interactions with the environment and the MRT is a valid indicator of school readiness, then such development should be measurable. If a relationship exists between the concrete problem solving involved in constructuve play and the abstract problem solving encountered in the classroom, then school readiness may be a more complex phenomenon than the maturity factor alone would indicate.

Method

In order to determine if such an effect might take place, a group of ten kindergarten students was used as subjects in an activity involving action on objects and social interaction. The group had taken Level I of the MRT. The vehicle for performance of these operations was a constructive play activity using various building toys. The children worked in pairs. A barrier was placed between the two children. Child A constructed a configuration which child B could not see. Child A then proceeded to describe the steps taken in order for child B to reproduce the configuration, sight unseen. Discussion and questions were encouraged from both sides of the barrier. No visual communication, such as showing a building piece or gesturing, was allowed.

This activity was designed to duplicate, using concrete materials instead of symbols, the part-whole tasks required in symbolic problem solving. The treatment period involved four weeks of constructive play activities, five days per week. The children were then tested using Level II of the MRT. Another group of ten kindergarten students, also tested using Level I

of the MRT, remained in their classroom. They too, were given Level II of the MRT at the end of the treatment period.

Subjects

The population for the study consisted of kindergarten students in the Santa Clara Unified School District, Santa Clara County, California. The district includes portions of the cities of Sunnyvale and Alviso, as well as Santa Clara. The socioeconomic levels represented in the population range from lower through upper-middle income groups.

The sample included twelve boys and eight girls, chosen at random from their class, through a process involving the drawing of names (Best, 1977). They were then assigned, ten each, to the experimental and control groups through the same process.

Materials

Materials used in the constructions included manipulatives familiar to most young children. Small wooden building blocks in five shapes, three sizes, two thicknesses, and four colors were used the first two weeks. Preschool Tinkertoys (slightly larger than standard) were used next. The final week included the use of 3-D Shapees in the constructions. These are plastic pieces of various shapes, grooved on sides, fronts, and backs to fit together in a variety of ways. The materials were varied to maintain interest and present new challenges to thought and action. A portable chalkboard was supported by large wooden building blocks to form an easily removable barrier between the subjects. Building boards, two feet square, were used as work spaces, allowing constructions to be saved from day to day if necessary.

Procedure

The Metropolitan Readiness Tests, Level I was used as a pretest. The test was administered in September when the children entered kindergarten. Level II, administered the following April, was used as a posttest. Both tests were administered by the classroom teacher, a standard district procedure.

The experimental group, six boys and four girls, participated in a four week, five day per week, treatment period. Treatment consisted of a series of building activities using construction toys. The children in the control group, also six boys and four girls, remained in their classroom. They were involved in small and whole group lessons covering various curriculum areas. The work included paper/pencil tasks as well as manipulative activities and language development experiences.

The experiment involved placing a visual barrier between two children as they sat on the floor in a small workroom adjacent to their classroom. The children had identical sets of building materials. They were instructed:

> You will be building whatever you like with these toys. When you finish your building, you will tell your friend on the other side of the wall, what to do to build the very same thing. Think about the shape, size, color, and thickness of each piece you use. Think about how you are placing it in your building. Think about what you do first, next, last. You will not be able to look at each other's work until everything is finished.

Verbal interchange was encouraged during the reproduction phase of the task. The child taking instruction was urged to clarify each

direction by repeating, commenting on, or questioning what was heard. Building pieces were not to be held up for verification. Gesturing was not allowed. All communication was to be strictly verbal.

The barrier was removed upon completion of the task. The children were then able to compare their constructions. If any differences existed, both children were given an opportunity to make adjustments in the reproduction. The task was not considered to be complete until both children agreed to the likeness of the two constructions.

The children were told that each of them would be given an opportunity to build something for the other to copy. If time ran out, they would be able to complete their task the next day. While one child was preparing a construction, the other used the time to explore the materials. One work period usually gave each child an opportunity to produce a construction and to reproduce another. Each session lasted approximately one hour. The time varied slightly depending upon the children involved. The length of the kindergarten session allowed three pairs to work each day.

Data Analysis

Data analysis included the use of t-tests to determine the significance of the difference between means for all areas examined. Raw scores were used for comparison of achievement in all tests. MRT scores were compared to reveal the following relationships:

1. MRT, Level I: experimental to control group
2. Experimental group: MRT, Level I to Level II
3. Control group: MRT, Level I to Level II

4. MRT, Level II: experimental to control group

Results

Achievement on the Metropolitan Readiness Tests, Levels I and II was evaluated and raw scores compared through the use of t-tests (Smith, 1970). Comparisons were made between scores for the experimental and control groups on Level I and Level II. Comparisons were also made to determine if any significant difference in performance existed for each group from Level I to Level II.

Data analysis revealed no significant difference ($t = .42$, p NS) between the experimental and control groups on the pretest, Level I of the MRT. (See Table 1)

Insert Table 1 about here

Achievement was compared for each group from Level I to Level II of the MRT. When t-tests were conducted, the results yielded significant improvement ($t = 6.68$, $p > .001$) for the experimental group. (See Table 2)

Insert Table 2 about here

The control group, which remained in the classroom, also showed significant improvement ($t = 2.26$, $p > .05$) from Level I to Level II. (See Table 3)

Insert Table 3 about here

Data analysis revealed a significant difference ($t = 2.96$,

$p > .01$) between the experiemntal and control groups on the posttest, Level II of the MRT. (See Table 4)

Insert Table 4 about here

Discussion

Piaget (1964/1967) has theorized that knowledge is constructed through action on objects and social interaction. Equilibration is the result with understanding acquired through the fitting of present experience into an established framework of knowledge. This process is mediated by the child's level of maturation. Studies by Piaget and others have pictured the child gradually schematizing a personal space in which the self is viewed as one object among others. The very young child first performs operations on the physical world. The development of the representative system of language speeds and refines both the acquisition of knowledge and the system used to express that knowledge. The same interactive, constructive processes seem to operate on the abstract level as the child moves into reading, writing, and mathematical operations.

The results of the present study indicate that the children who engaged in physical activity and social interaction, when verbal communication was encouraged, were more adept in handling the symbolic tasks encountered on the Metropolitan Readiness Tests than were their peers who did not. The children were all growing and changing, maturing, as the school year progressed. They were tested with Level I of the MRT in September, when they entered kindergarten. At that time, the experimental and control groups

showed no significant difference in their handling of the tasks presented on the MRT. Yet, in April, the experimental group had a definite edge in dealing with Level II. The study involved only ten children in one classroom. Future study involving more subjects would further establish the relationship between physical problem solving activity and social interaction, and abstract problem solving competence.

The children in the experimental group dealt with problems involving classification and seriation within a spatial framework. Although the materials were concrete objects, the part-whole problems encountered mirrored those of reading, writing, and mathematical operations. The constructions required spatial arrangements of elements according to more than one characteristic (shape, size, color, placement) in order to construct and reconstruct the whole. As with the schematization of letters in words, the parts, which were also wholes to be dealt with, had to be integrated to form new wholes. Placement within the spatial configuration had to be considered and appropriate language applied and communicated. This was considered to be the same skill required in the phonetic decoding process as well as in the formulation of equations in mathematics. The children had to classify, using more than one characteristic, seriate, reverse, and retrace actions, while considering and communicating outcome. They dealt with relationships involving class and order just as they would in determining the structure of letters and words in reading and writing. The arrangement of elements in an addition equation is much the same. Understanding that 3 + 5 and 4 + 4 both equal 8 requires part-whole thinking which is flexible.

Such thought must conserve the identity of the whole as well as its parts. There seems to exist a relationship between the child's design for a block castle and that child's conception of words and equations.

In the present study, each child constructed a whole then mentally retraced the steps taken in order to communicate instructions to another person. The other child would then have to reproduce the whole. A communication had to be encoded out of action into language. Language then had to be decoded back into action. Thus, the task could be completed. The need to deal with the intricacies of language was evident as the children struggled to communicate their knowledge through their own symbolic systems.

Questions across the barrier were indicative of the children's attempts to deal with the spatial problems inherent in their constructions. Discussion often involved questions of left-right placement of objects. There was much confusion in dealing with left and right because the children were facing each other as they worked. Several became aware of the reversal of left and right for the first time during these activities. The children's use of language to extend their knowledge seems to support Piaget's (1971) statement that in order to become conscious of an operation, it must pass from the plane of action to that of language. It must be reinvented in imagination in order to be experssed in words. The children in the present study were involved in a process of organizing their space through the use of symbols, as described by Barsch (1967).

Furth and Wachs (1975) note that through visual thinking, laterality and directionality are integrated to provide a

relative constancy of objects in space. They state that this is the basis for learning directionality in letters, words, and numerals.

Similarly, Elkind (1966) found schematization and reorganization to be essential to the reading process. The children in the experimental group were using these activities to solve their problems of action, thought, and communication. They were performing those same complex and varied perceptual acts which Elkind saw as vital to the reading process.

Piaget (1964/1967) has theorized that knowledge is constructed through the coordinating of actions on and interactions with the environment, mediated by the child's level of maturation, refined by previous understandings. This interactive, constructive process may better define the concept of readiness that those characteristics enumerated by the authors of the MRT (Hildreth, McGauvran, and Griffith, 1977). Further investigation might examine physical activity and social interaction, involving both objects and other beings, in relation to maturational factors. Piaget and Inhelder (1966/1969) state that while organic maturation is undoubtedly a necessary factor, it does not explain all development. The present study suggests that a relationship exists between success in physical problem solving activity, when verbal communication is encouraged, and symbolic problem solving competence. Knowledge constructed through action, thought, and language may well be the basis for academic skill and higher order conceptualization.

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Table 1

Evaluation of Raw Scores: Experimental to Control Group

MRT Level I

Experimental Group	Control Group
M = 60.4	M = 58.5

t (18df) = .42 p NS

Table 2

Evaluation of Raw Scores: MRT, Level I to MRT, Level II

Experimental Group

MRT Level I	MRT Level II
M = 60.4	M = 85.6

$t\ (18df) = 6.86\ p > .001$

Table 3

Evaluation of Raw Scores: MRT, Level I to MRT, Level II

Control Group

MRT Level I	MRT Level II
M = 58.5	M = 71.1

t (18df) = 2.26 $p > .05$

Table 4

Evaluation of Raw Scores: Experimental to Control Group

Experimental Group	Control Group
M = 85.6	M = 71.1

$t\ (18df) = 2.96 \quad p > .01$